worldsteel ASSOCIATION

FACT SHEET

Advanced applications

Advanced steel applications help to address climate change

Across a broad range of industries and applications, the development and use of high-performance steels help to reduce greenhouse gas emissions.

Steel is one of the most efficient modern construction materials. It offers the highest strength-to-weight ratio of any commonly-used material and is exceptionally durable. Over 20 billion tonnes of steel remains in use today in a variety of products. Steel can be infinitely recycled, allowing the creation of new products out of old products without any loss of strength, formability, or any other important measure of performance. This is why steel remains the material of choice for construction and manufacturing around the world.

New formulations of high-performance steels enable carmakers to produce stronger and lighter vehicles that are more energy efficient. Steel offers considerable advantages for the construction of wind turbine towers due to its strength and durability. Environmental impacts are minimised as steel can be infinitely recycled. The strength of steel also enables building designers to use less material without compromising structural performance. Steel is also part of innovative technologies that reduce energy use in buildings.

Designed for the purpose

Steel can be designed for the purpose of the end-use application and the specific strength, durability and end-of-life recycling requirements. New and sophisticated manufacturing processes have also introduced environmentally-responsible production methods.

New steel applications have replaced conventional materials. This has contributed to the reduction of greenhouse gas emissions when the total life cycle of the application is taken into account. This fact sheet presents some examples of these applications.

Steel in transport

Rail transport requires steel in the trains and for the rails and infrastructure. For short- or medium-haul journeys, rail reduces travel times and CO_2 emissions per passenger km compared to nearly all other forms of transport.[1]

Automotive manufacturers now use a range of high-strength steels to make much thinner steel structures for car bodies. Reduced weight means vehicles are more fuel-efficient and emit less CO_2, without sacrificing safety and with little or no additional cost.

Advanced High-Strength Steels (AHSS) are now used for nearly every new vehicle design. Steel makes up more than 50% of today's vehicles, and using AHSS makes possible lighter, optimised vehicle designs that enhance safety, improve fuel economy and reduce lifetime greenhouse gas emissions.[2]

With 71 million passenger vehicles produced annually, this transformation from conventional steels to AHSS has a huge impact. About 2.2 tonnes less greenhouse gas is produced over the total life cycle of a typical five passenger vehicle when it is transformed from conventional steels to new AHSS grades and optimised design techniques. This saving in emissions is more than the total amount of CO_2 emitted during the production of all the steel in the vehicle. If the body structure of all the cars produced in 2008 were made from AHSS, 156 million tonnes of CO_2 equivalents would have been avoided.

The 2008 Ford Fiesta, for example, makes extensive use of ultra high-strength steels in its body structure. Ford states that, "A remarkable amount of specialist steels, including boron steel and dual-phase steel, is the secret to the Fiesta's quantum leap in structural stiffness for its light weight." In fact this new vehicle promises to deliver CO_2 emissions of less than 100 g per km.[3]

Another new vehicle, the 2008 Mazda 2, has a curb weight of 950 kg, 100 kg less than its predecessor. This weight reduction is in part due to a redesigned and lighter body consisting of more than 40% high-strength steel. Consequently, it has lighter suspension and braking systems. These and other design improvements mean this latest model can offer a 15% increase in fuel efficiency over its predecessor, with a corresponding reduction in CO_2 emissions.[4]

In the premium class, the 2008 Mercedes C-Class is one of the few vehicles to receive an internationally-accredited environmental certificate for its life cycle assessment (LCA) performance. The body of the C-Class is 70% high-strength-steel alloys, which results in a 9 tonne reduction in CO_2 emissions per vehicle over its lifetime.[5]

Steel in energy

Steel is necessary for both the production and supply of energy. It is used in electricity pylons and to make offshore oil platforms and it reinforces concrete structures in hydroelectric power stations. Without steel, the infrastructure to supply electricity to our homes would be extremely inefficient.

Steel is such a well-used material in modern structures that we are often unaware of the design efficiencies they embody. A prime example is the tubular steel towers used for the wind turbines now being installed around the world. Generally, taller towers offer greater energy generating efficiency, since wind speeds increase at higher altitudes.

The new steels used in the construction of such towers offer much higher strength-per-unit weight ratios than other materials, so taller towers can be erected with much less stress on the structure. Lower weight also enables these towers to be manufactured in sections of up to 30 m, then assembled and installed on site.

Ongoing research continues to produce new steels that are even stronger than their predecessors, and thus will minimise the mass of future towers. As a result, tower weights (per installed power in kW) have declined by about 50% during the past 10 years.[6] A typical modern tower in the Horns Rev wind farm in Denmark is 70 m high and weighs only 140 tonnes.[7] This represents a 50% reduction in weight and a saving of more than 200 tonnes of CO_2 for each tower compared to its predecessors of just 10 years ago.[8]

Steel in buildings

New steels are also applied in modern solar heating systems for large buildings and warehouses. For example, the Canadian SolarWall® air heating system recently installed in a military base in the US is designed to save over 1,800 tonnes of CO_2 a year.[9] It is also projected to realise fuel savings of 46,000 GJ a year.

Another advanced steel application for buildings is the Arsolar solar panel roofing system, developed by ArcelorMittal. Arsolar roofing converts solar energy to electricity. Each Arsolar roof module consists of photovoltaic sandwich panels assembled onto galvanised steel roofing panels. The system saves 30 tonnes of CO_2 a year for every 45 m^2 of installation.[10]

Steel in shipbuilding

Shipbuilding traditionally uses structural steel plate to fabricate ship hulls. Modern steel plates have much higher tensile strengths than their predecessors, making them much better suited to the efficient construction of large container ships.

A particular type of plate is available with a designed-in resistance to corrosion, ideal for building oil tankers. Such steels make possible much lighter vessels than before, or larger-capacity vessels for the same weight, offering significant opportunities to save on fuel consumption and hence CO_2.

The advanced steels used in these steel-plate applications also find uses in a number of related industries. Offshore oil rigs, bridges, civil engineering and construction machines, rail carriages, tanks and pressure vessels, nuclear, thermal and hydroelectric plants – all these applications benefit from the attributes of modern steels.

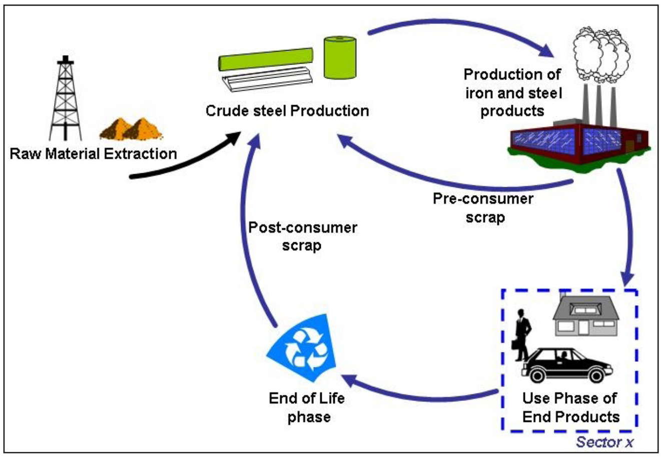
The importance of life cycle assessment

The above are just a few examples of the many ways in which advanced steels are used in our everyday environment. There are many more. The common factor is that they are based on modern designed-for-the-purpose steels, which offer features and benefits specifically tailored to each application.

When considering greenhouse gas emissions, a key factor in understanding the real environmental impact of a material is its LCA. This approach considers the total greenhouse gas emissions generated by the production, use and end-of-life (recycling or disposal) phases of a product.

At first glance, materials that weigh less than steel, such as aluminium, magnesium and plastics, may appear to be interesting alternatives. However, when the total life cycle of a material is taken into account, steel has no competition, owing to its strength, durability, recyclability and versatility.

The life cycle of a steel item in a multi-material product[11]



Some facts about steel

- Steel is 100% recyclable at the end of its life. Alternatively it can be reused prior to being recycled.
- Some 2.2 tonnes less greenhouse gas is produced over the total life cycle of a typical five passenger car when the vehicle's body is manufactured using AHSS.
- The CO_2 savings made by recycling steel packaging in Europe in 2006 were equivalent to the CO_2 produced by 1.6 million cars in the same year, based upon a compact car (e.g. Ford Focus 1.8 diesel) with a CO_2 emissions rating of 137g/km that travels 20,000 km in one year.[12]
- An estimated 459 million tonnes of steel scrap were recycled in 2006, avoiding 827 million tonnes of CO_2 emissions.[13]
- The steel can is the most recycled food or beverage container in the world, with an overall recycling rate of 67%.[14]
- Where collection and handling systems are in place, recycling rates are very high. 97% of all automotive vehicles are moved out of the waste stream and into the recycling stream and the engine that drives this recycling is steel.

Last updated: October 2008

Footnotes

1. Chapman, L., 2007, "Transport and climate change: a review"; Eurostar & AEA Technology Environment, 2008 (www.eurostar.com)
2. An LCA-GHG Parametric Model, Dr Roland Geyer, Dr Donald Bren School of Environmental Science and Management, University of California Santa Barbara, 2006. This study also forms the basis for other statements and calculations made in this fact sheet.
3. Ford Motor Company news release, March 2008
4. worldautosteel.org
5. Mercedes-Benz (http://www2.mercedes-benz.co.uk/)
6. Danish Wind Industry Association, www.windpower.org
7. Vestas Wind Systems, 2004, LCA of offshore and onshore wind farms (www.vestas.com)
8. When compared to the world average emission factor for electricity of 0.504 tCO_2/MWh, World Steel CO_2 Emissions Data Collection User Guide, v. 3.
9. Solarwall (www.solarwall.com)
10. ArcelorMittal (http://www.arcelormittal.tv/2008/06/19/arcelormittal-develops-an-innovative-and-award-wining-solar-panel/)
11. University of Stuttgart, Chair of Building Physics, Department of Life Cycle Assessment 2007
12. APEAL (www.apeal.org)
13. World Steel Association World Steel in Figures 2008, second edition
14. IISI packaging press release, 2008 (www.worldsteel.org)